

REMARKS

The present amendment amends claim 1 and adds new claims 8 and 9 to depend from claim 1. Thus, the pending claims in this application are claims 1-3 and 5-9, with claim 1 being the sole independent claim.

Claim 1 is amended to clarify that the reaction is carried out in a reaction apparatus to produce a resultant reaction liquid containing crude hydroxyalkyl (meth)acrylate, unreacted (meth)acrylic acid and unreacted alkylene oxide. Claim 1 is also amended to recite introducing the resultant reaction liquid into a distillation apparatus and distilling the resultant reaction liquid to recover the unreacted (meth)acrylic acid as a distillate. Claim 1 also recites recycling and introducing the distillate containing recovered unreacted (meth)acrylic acid from the distillation apparatus to the reaction apparatus. These features are fully supported by the specification as originally filed.

New claim 8 depends from claim 1 to recite the step of purifying the resultant reaction liquid after the unreacted (meth)acrylic acid is recovered by the distillation step. Support for new claim 8 is found on page 16, line 19 to page 17, line 6 of the specification. This passage specifically discloses the step of purifying the crude hydroxyalkyl ester. Claim 9 depends from claim 8 to recite the step of purifying the resultant reaction liquid by distillation after the unreacted (meth)acrylic acid is recovered by a first distillation step. Support for claim 9 is also found on page 16, line 19 through page 17, line 6.

In view of these amendments and the above comments, reconsideration and allowance are requested.

Rejection Under 35 U.S.C. § 103(a)

In the previous Office Action, claims 1-3 and 5-7 are rejected as being obvious under 35 U.S.C. § 103(a) over U.S. Patent No. 6,414,182 to Shingai et al. Shingai et al. is cited for disclosing the reaction between a carboxylic acid and an alkylene oxide to produce a hydroxyalkyl ester where the hydroxyalkyl ester is purified by distillation.

Claim 1, as amended, recites the process for producing the hydroxyalkyl (meth)acrylate by reacting (meth)acrylic acid and an alkylene oxide in a reaction apparatus to produce a resultant reaction liquid in the reaction apparatus containing crude hydroxyalkyl (meth)acrylate, unreacted (meth)acrylic acid and unreacted alkylene oxide. The resultant reaction liquid is then introduced to a distillation apparatus and distilled under an operational pressure of 1 to 40 hPa to obtain a distillate and to recover the unreacted (meth)acrylic acid. The unreacted (meth)acrylic acid in the distillate from the distillation apparatus is then recycled and introduced to the reaction apparatus as a raw material for the reaction.

Shingai et al. does not disclose the claimed process steps. The Advisory Action refers to column 2, lines 30-40. As noted in the previous Office Action, this passage discloses that the reaction process often yields less than 100% and that the unreacted reactants can be recovered. However, this passage discloses that the reaction liquid is first treated to remove the unreacted residues of the raw materials from the reaction liquid. Further, this passage does not disclose a method for separating and recycling the unreacted raw materials. This passage also discloses that the subsequent and final step purifies the reaction liquid by distillation to obtain the hydroxyalkyl ester. Specifically, this passage discloses that the reaction liquid is treated to recover the unreacted raw materials “and then purified by such as distillation as the subsequent final step.” (Emphasis added). Therefore, this passage clearly discloses that the unreacted materials are removed in a first separation step and then the

reaction liquid without the unreacted materials is distilled to purify the hydroxyalkyl ester. Shingai et al. does not disclose or suggest that the unreacted raw materials are removed by the distillation step under a specified operational pressure as presently claimed. Furthermore, Shingai et al. does not disclose recovering unreacted (meth)acrylic acid from the distillation apparatus during the distillation of the reaction liquid containing the unreacted raw materials and crude hydroxyalkyl (meth)acrylic acid, and thereafter recycling and introducing the recovered (meth)acrylic acid to the reaction apparatus.

Shingai et al. does not disclose or suggest an operational pressure for the distillation. The distillation of the reaction liquid in the present invention is carried out under an operational pressure of 1 to 40 hPa. In the case where the pressure is lower than 1 hPa, the saturation temperature of the vapor including the (meth)acrylic acid is lowered at the top of the distillation column, and it is difficult to condense and recover this vapor by passing it through a condenser with cooling water. In the case where the pressure is higher than 40 hPa, there are disadvantages that: 1) the temperature rises in the distillation column, especially at the bottom of the distillation column; and 2) the polymerization and clogging are caused in the column while the distillation procedure is carried out; and then the procedure is stopped. See, for example, page 11, line 13 to page 12, line 2 of the specification.

Shingai et al. distinguishes between the step of recovering the unreacted residues and the step of purifying the hydroxyalkyl ester. The Advisory Action suggests that one skilled in the art would understand removing impurities from (meth)acrylic acid as meeting the claimed limitation of recovering (meth)acrylic acid by distillation. Claim 1 specifically recites distilling the reaction liquid containing the unreacted components and the hydroxyalkyl ester in a distillation apparatus and recovering the unreacted (meth)acrylic acid by the distillation step under a specified operational pressure. Even when claim 1 is given its broadest

reasonable interpretation, claim 1 still recites recovering the unreacted (meth)acrylic acid by the distillation from the reaction liquid. Claim 1 is not properly interpreted as encompassing any process for removing or recovering unreacted (meth)acrylic acid and thereafter distilling the reaction liquid after the unreacted materials have been removed from the reaction liquid.

Shingai et al. does not recognize that the unreacted (meth)acrylic acid can be recovered by distillation or that the distillate can be recycled to the reaction apparatus. As noted above, Shingai et al. discloses removing the unreacted reactants from the reaction in a first step and thereafter purifying the hydroxyalkyl (meth)acrylate by distillation. There is no suggestion that the distillates obtained from the distillation step of Shingai et al. contain unreacted (meth)acrylic acid or that the distillate can be recycled to the reaction apparatus.

As disclosed on page 2 of the specification, (meth)acrylic acid has a strong affinity for the hydroxyalkyl (meth)acrylate and has a low relative volatility. Therefore, the recovering and recycling of unreacted (meth)acrylic acid can be difficult to carry out. The present invention is directed to the discovery that the resulting reaction liquid containing unreacted (meth)acrylic acid, unreacted alkylene oxide and the resulting hydroxyalkyl (meth)acrylate can be distilled to recover and recycle the unreacted (meth)acrylic acid. Shingai et al. does not disclose recycling (meth)acrylic acid that is recovered from a distillation step of the reaction liquid. Further, Shingai et al. does not suggest any other method for recovering unreacted (meth)acrylic acid.

The passage of Shingai et al. referred to in the previous Office Action discloses that the reaction liquid is treated conventionally to remove the unreacted residues of the raw material. The reaction liquid is distilled to remove impurities from the resulting hydroxyalkyl (meth)acrylate after the unreacted (meth)acrylic acid is recovered by the conventional methods. Thus, Shingai et al. removes the unreacted (meth)acrylic acid before the reaction

liquid is distilled such that the reaction liquid that is subjected to the distillation contains little or no unreacted (meth)acrylic acid.

Shingai et al. discloses generally recycling of unreacted materials by separating a portion of the reaction liquid from the outlet stream of the reactor and redirecting the reaction liquid to the inlet of the reactor without any processing or treatment. There is no disclosure or suggestion of separating or recovering the unreacted (meth)acrylic acid from the resulting hydroxyalkyl ester and then recycling only the recovered unreacted (meth)acrylic acid.

It is not obvious to one of ordinary skill in the art to distill the reaction liquid containing unreacted (meth)acrylic acid, unreacted alkylene oxide and the resulting hydroxyalkyl ester to recover and recycle the unreacted (meth)acrylic acid as recited in claim 1. Shingai et al. provides no suggestion of distilling the reaction liquid to recover the (meth)acrylic acid from the reaction liquid withdrawn from the reaction apparatus. Shingai et al. also provides no suggestion of distilling the reaction liquid at a pressure of 1 to 40 hPa to recover and then recycle the (meth)acrylic acid. The importance of the operating pressure is evident from Comparative Example 1 and Comparative Example 2 of the specification and as disclosed on page 11, line 13 to page 12, line 2. The distillation of the reaction mixture at a pressure above the range recited in claim 1 forms a polymerized product which can cause clogging of the column. As shown in Comparative Example 2, a pressure below the claimed range results in uncondensed vapor in the top of the condenser which makes it difficult to recover and condense the vapor.

In view of the above comments and these amendments, claim 1 is submitted to be allowable over Shingai et al. Claims 2, 3 and 5-9 depending from claim 1 are also allowable for reciting additional aspects of the invention which in combination with the process steps of claim 1 are not obvious in view of Shingai et al. For example, Shingai et al. does not disclose

or suggest distilling the resultant reaction liquid to recover and recycle unreacted alkylene oxide together with the unreacted (meth)acrylic acid as in claim 2. Shingai et al. also fails to disclose or suggest a first step of separating and recovering the unreacted alkylene oxide from the resulting reaction liquid and thereafter distilling the reaction liquid to recover the unreacted (meth)acrylic acid as in claim 3, distilling the resultant reaction liquid with a plate column and/or packed column as in claim 5, distilling the reaction liquid in the presence of polymerization inhibitors as in claim 6, or distilling a reaction liquid containing 0.1 to 20 weight% unreacted (meth)acrylic acid as in claim 7 in combination with the process steps of claim 1.

Shingai et al. also fails to disclose the step of distilling the reaction liquid to recover the unreacted (meth)acrylic acid by the distillation step and thereafter purifying the resultant reaction liquid containing the crude hydroxyalkyl (meth)acrylate (after the (meth)acrylic acid is removed) as in claim 8 in combination with the process steps of claim 1. Shingai et al. also does not disclose the step of purifying the resultant reaction liquid by a second distillation step as recited in claim 9 in combination with the process steps of claims 8 and 1.

In view of the above comments, claims 1-3 and 5-9 are submitted to be in condition for allowance. Accordingly, reconsideration and allowance are requested.

Respectfully submitted,



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